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(54) Vehicle, particularly electrically driven vehicle

(57) In order to contain a wheel suspension (1) with an electric motor (21) and a transmission in a compact manner within a vehicle, in which the required wheel motions can be made, the electric motor (21) and the transmission are placed in the wheel housing (3) ofthe vehicle, and the wheel shaft (13) is on bearings in a housing (15) that is connected with hinges at two places with a yoke (37). So the housing (15) forms a stub axle. The yoke (37) is connected to the vehicle in a hinged manner via supporting arms and is C-shaped, with the top end (47) ofthe yoke being located above the wheel. The lower supporting arm is connected to the vehicle under the floor surface. To simplify (dis-) assembly, the yoke (37) is divided near the hinge point of the lower supporting arm. The electric motor (21) and transmission can be installed in the specified housing (15) or can be installed against the wheel housing (3), in which latter case coupling with the wheel takes place via a drive shaft (117).

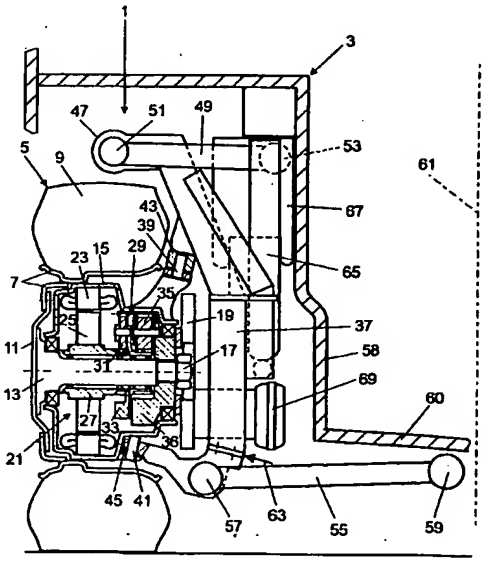

FIG. 1

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Description

Field of the invention

[0001] The invention relates to a vehicle, specifically an electrically driven vehicle, comprising a number of driven wheels each of which is supported on bearings in a housing that is connected to the rest of the vehicle via supporting arms ofa wheel suspension, which wheels can be driven by an electric motor via a transmission, whereby the electric motor and the transmission are present in a space present in the vehicle for the wheel suspension. This space for the wheel suspension is usually the space in the wheel housing ofthe vehicle. The electric motor and the transmission can be integrated in the specified housing or they can be positioned in the vicinity ofthe wheel to be driven in the wheel housing and fastened to the body of the vehicle. However, for structural reasons the wheel housing can be made smaller and the electric motor with transmission can be installed on the interior of the vehicle against the wheel housing. In this case the space just outside the wheel housing, on the inside of the vehicle, should also be considered to comprise the specified space for the wheel suspension. Such drive constructions are compact in structure and are utilized in vehicles in which the available installation space is limited or where power transport from the power source to the driven wheels via a mechanical route is not desirable, for example due to a low floor that would even make it impossible to mechanically couple the drive shafts of two wheels to each other on the same shaft, or because there is a great distance between the wheels being driven. Wheel suspensions in which the wheel is fastened to the vehicle by supporting arms are utilized for vehicles in which the wheels must have a broad range of motion in order, for example, to compensate for a very uneven road and/or very sharp curves. Since in the interest ofthe environment electrical drive systems are becoming increasingly desirable, more and more types of vehicles are being designed with electrical drive systems.

Prior art

[0002] A vehicle of the type as described in the preamble is known from the American patent specification US 5.004.061. In that vehicle the ends ofthe supporting arms of the wheel suspension are connected in a hinged manner with the housing in which the wheel shaft rests on bearings and in which the drive and transmission are located. The other ends of the supporting arms are connected with hinges to the vehicle, which in this case is a golf cart. Thanks to the great amount of available space the wheel suspension can be installed without any problems.

[0003] Whereas in the past electrical drive systems were utilized chiefly for rail vehicles, trolley buses, and golf carts, these days electrical drives are being used with increasing frequency in other types ofvehicles. Since in most vehicles it is desirable to keep the installation space as small as possible in connection with the maximal amount of space available for the passengers or the freight, the wheel suspension in combination with the possible wheel drive should be as compact as possible. The known wheel suspension demands too much installation space to be able to meet the standards of compactness in vehicles intended for the transport of persons and/or goods.

Summary of the invention

[0004] An objective of the invention is to produce a vehicle of the type as described in the preamble in which the structure of the suspension and of the drive of the wheel is more compact and requires less installation space than the wheel suspension of the known vehicle. To this end the vehicle according to the invention is characterized by the fact that the wheel suspension comprises a yoke that is connected with the housing whereby an end of each supporting arm is connected in a hinged manner to the yoke. By utilizing a yoke the connection points with the supporting arms can be shifted, facilitating a more compact structure.

[0005] Though it is true that wheel suspensions in which a yoke is utilized do already exist, a combination of such a wheel suspension with a drive located in the space in the vehicle meant for the wheel suspension is new. As a result of this new combination a wheel suspension with an electric motor and transmission is obtained that requires only a minimal amount of installation space and in which broad wheel motions are possible

[0006] One embodiment of the vehicle according to the invention is characterized by the fact that the electric motor and the transmission are located in the housing. This results in a structure that is very compact.

[0007] Another embodiment of the vehicle according to the invention is characterized by the fact that the electric motor and the transmission are located a distance from the housing and positioned in or near the wheel housing of the vehicle and fastened to the body of the vehicle, with the wheel shaft being connected with the transmission via a drive shaft. This results in a structure in which the unsprung weight is low yet requires minimal installation space. An additional advantage of this structure is that the electrical cables and possible cooling water hoses no longer need to move along with the wheel in terms of the body of the vehicle. The electric motor and transmission can be fastened directly or via auxiliary elements to the wheel housing.

[0008] Another embodiment of the vehicle according to the invention is characterized by the fact that the yoke of the wheel suspension is connected in two places in a hinged manner with the housing, so that the housing forms a stub axle. This makes the wheel suspension also suitable for steerable wheels. An additional advantage of a yoke is the virtually vertical motion of the yoke

at spring movements. So if an air spring bellows is used this would be less subject to wear and tear.

[0009] Another advantage of using a yoke is that in the connection with the housing it is not necessary for ball hinges to be used. So another advantageous embodiment is characterized by the fact that each connection of the yoke with the housing contains a bush containing a swivel pin, with the possibility of the swivel pin and the bush being turned in relation to each other, and with the swivel pin being fastened to the housing or the yoke and the bush being fastened either in the yoke or in the housing.

[0010] Yet another embodiment is characterized by the fact that the yoke is C-shaped, such that the top end of the yoke, when there is a wheel on the wheel shaft, is located above the wheel and the uppermost supporting arm is connected in a hinged manner with this end. By this placement ofthe uppermost supporting arm, the interior space in the vehicle between the wheels is considerably greater and the floor height in the interior between the wheels can remain low in comparison with the rest of the vehicle, so that the passengers can move freely in and out of the vehicle.

[0011] Another embodiment associated with the previous one is characterized by the fact that, if the wheel suspension is built into a vehicle, the lower supporting arm, under the floor surface of the vehicle, is connected with the body of the vehicle. Preferably here the undermost supporting arm is connected with the vehicle near its longitudinal central surface.

[0012] To simplify the assembly and disassembly of the wheel suspension another embodiment is characterized by the fact that the yoke consists of at least two parts that are connected with each other such that they can be taken apart. Preferably the yoke is divided near the hinge point of the undermost supporting arm.

[0013] To be able to better utilize the available space in the wheel, another embodiment is characterized by the fact that the end of the wheel shaft extends from the housing on the side of the yoke, with a brake disc being attached to the specified protruding end. An advantage of this structure is that the brake pads and brake disc can be easily replaced without any need for the wheel to be removed.

[0014] Another embodiment is characterized by the fact that the transmission present in the housing comprises at least two steps, one of which is present on each side of the electric motor. The outgoing shaft ofthe electric motor is fastened to the incoming shaft of one of the steps, with the outgoing shaft being hollow and going through the electric motor and being connected to the incoming shaft of the other step, the outgoing shaft of which is fastened to the wheel shaft that goes through the specified hollow shaft. Another embodiment is characterized by the fact that the vehicle comprises a subframe to which the supporting arms are hingedly connected with an end. For this reason the assembly of the wheel suspension can be done independently of the assembly of the vehicle for which the wheel suspension is intended, which may be efficient in terms of assembly. In addition using a subframe can contribute to the structure of the vehicle in terms of strength and rigidity.

Brief description of the drawings

[0015] The invention will be elucidated more fully below by means of drawings in which different embodiments of the vehicle according to the invention are shown. In these drawings:

Figure 1 shows a cross section of a wheel suspension and a drive of a first embodiment of the vehicle according to the invention;
Figure 2 shows a top view of the wheel suspension and drive shown in figure 1;
Figure 3 shows an electric motor and transmission of a second embodiment of the vehicle according to the invention;
Figure 4 shows a cross section of a wheel suspension and a drive of a third embodiment of the vehicle according to the invention;
Figure 5 shows a top view ofthe wheel suspension and drive shown in figure 4; and
Figure 6 shows a side view of the wheel suspension and drive shown in figure 4.

Detailed description of the drawings

[0016] Figure 1 shows a wheel suspension of a first embodiment of the vehicle according to the invention. The wheel suspension 1 is built into the wheel housing 3 ofthe vehicle. The wheel suspension 1 has a wheel 5 with a rim 7 upon which a tyre 9 is present. The rim 7 is attached with bolts to a flange 11 on a wheel shaft 13. The wheel shaft 13 is supported on bearings in a housing 15 and extends from the housing with an end 17. At this end 17 a brake disc 19 is fastened. In the housing 15 there is an electric motor 21 for the drive of the wheel 5. The electric motor 21 has a stator 23 that is fastened to the housing 15 and a rotor 25 that is fastened to a bush 27 supported on bearings on the wheel shaft 13.

[0017] In the housing 15 there is also a transmission 29 that consists of a double planetary gearing. The bush 27 is toothed at the end and the teeth mesh with planet gears 31. The planet gears 31 are supported on bearings on a planet carrier 33, that is supported on bearings on the wheel shaft 13 and in its turn meshes with other planet gears 35 of the second transmission. The planet gears 35 are supported on bearings on another planet carrier 36 that is fastened to the wheel shaft 13.

[0018] The housing 15 is connected to a yoke 37 in a hinged manner. The connection is formed by swivel pins 39 and 41 that are fastened to the housing 15 and can revolve in bushes 43 and 45 that are fastened to the yoke 37. The yoke 37 is C-shaped. The top end 47 is located above the wheel 5 and is suspended to the ve-

hicle via the upper supporting arms 49. These supporting arms 49 are hinged with an end 51 to the yoke 37 and with the other end 53 to the vehicle. On the underside the yoke 37 is suspended via the lower supporting arms 55 to the vehicle. These supporting arms 55 are hinged with an end 57 to the yoke 37 and with another end 59 to the body 58 of the vehicle under the floor surface 60 near a longitudinal central surface 61 of the vehicle. The yoke 37 is divided into two parts near the hinge point with the lower supporting arm 55. The place where the two parts are connected with each other is indicated by arrow 63. Between the yoke 37 and the wheel housing 3 of the vehicle there is also a shock absorber 65 and an air spring bellows 67 and there is a brake booster 69 at the housing. For the sake of clarity the brake callipers with brake shoes have been omitted here.

[0019] In figure 2 the wheel suspension 1 is shown from above. Here it is clearly visible that the yoke 37 is connected at its top end 47 with two upper supporting arms 49 and connected on the underside with two lower supporting arms 55. Of course the two upper supporting arms 49 can also be in the form of a single unit. The same applies to the lower supporting arms 55.

[0020] Figure 3 shows another embodiment ofthe housing that contains an electric motor and transmission. The electric motor 71 is approximately in the centre of the housing 73. The transmission 75 has two steps 77 and 79, with one being present on each side ofthe electric motor 71. The electric motor 71 has a stator 81 that is fastened to the housing 73 and a rotor 83 fastened to a revolving bush on bearings 85. The bush 85 forms the outgoing shaft of the electric motor and has a toothed end that meshes with the planet gears 87 of the first step 77. The planet gears 87 are on bearings on a planet carrier 89 that forms the outgoing shaft of the first step 77. The planet carrier 89 is formed by a hollow sleeve 91 provided with a flange 93 with a ring 94 connected to it that is on bearings on a wheel shaft 95. The planet gears 87 revolve around a shaft 96 that is fastened to the flange 93 and the ring 94. The sleeve 91 forms the outgoing shaft ofthe first step 77 as well as the incoming shaft of the second step 79, and it passes through the electric motor 71. On the other end the sleeve 91 has teeth that mesh with planet gears 97 of the second step 79. These planet gears 97 are on bearings on another planet carrier 99 that forms the outgoing shaft of the second step. This planet carrier 99 is finally fastened to the wheel shaft 95.

[0021] Figure 4 shows a cross section of a wheel suspension 101 with a drive of a different embodiment of the vehicle according to the invention. Here the transmission 103 and the electric motor 105 are fastened against the wheel housing 107. The wheel 109 is on bearings with a wheel hub 110 in housing 113. In this embodiment the housing 113 is the stub axle of the wheel suspension. A brake disc 115 is fastened to the wheel hub 110. The wheel shaft 111 is coupled to the wheel hub 110. The wheel shaft 111 is coupled with the transmission 103 via a drive shaft 117. The coupling between the drive shaft 117 on the one hand and the wheel shaft 111 respectively the transmission 103 on the other is established by two homokinetic couplings 119 and 121. The transmission 103 is located against the wheel housing 107 and the coupling 121 can be integrated into a gear 123 so as to be able to use a relatively long drive shaft 117, allowing broad spring movements where there are only small angle differences in the drive shaft. Two swivel pins 125 and 127 are fastened to the housing 113 around which bushes 129 and 131 can revolve. These bushes are fastened to a C-shaped yoke 133 that is suspended in the vehicle via supporting arms 135 and 137. Between the yoke 133 and the wheel housing 107 there is a shock absorber 139 and an air spring bellows 141.

[0022] Figure 5 shows a top view ofthe wheel suspension 101 with drive shown in figure 4. For purposes of clarity the yoke and the supporting arms of the suspension are not shown here. The electric motor 105 is located beside the transmission 103 which is shown more clearly in figure 6. By fastening the transmission 103 and the electric motor 105 against the wheel housing 107 one has more structural freedom than ifthese were integrated into the housing 113 of the wheel shaft 111. In addition a simpler gear transmission can be utilized than a double planetary gearing. In figure 6 the wheel 109 is shown, for purposes of clarity, by a broken line.

[0023] Although above the invention is elucidated on the basis of the drawings, it should be established that the invention is in no way limited to the embodiments shown in the drawings. The invention also extends to all embodiments deviating from the embodiments shown in the drawings within the context defined by the claims. For example the vehicle can also comprise a subframe to which the supporting arms are connected with a hinge at the end. The subframe can then, in its turn, be attached to the body ofthe vehicle rather than the supporting arms being directly connected to the body of the vehicle.

Claims

1. Vehicle, specifically an electrically driven vehicle, comprising a number of driven wheels each of which is supported on bearings in a housing that is connected to the rest of the vehicle via supporting arms of a wheel suspension, which wheels can be driven by an electric motor via a transmission, whereby the electric motor and the transmission are present in a space present in the vehicle for the wheel suspension, characterized in that the wheel suspension comprises a yoke that is connected with the housing whereby an end of each supporting arm is connected in a hinged manner to the yoke.

2. Vehicle according to claim 1, characterized in that the electric motor and the transmission are present in the housing.

3. Vehicle according to claim 1, characterized in that the electric motor and the transmission are present at a distance from the housing and positioned in or near the wheel housing of the vehicle and fastened to the body of the vehicle, whereby the wheel shaft is connected to the transmission via a drive shaft.

4. Vehicle according to one of the preceding claims, characterized in that the yoke is hinged in two places to the housing, with the housing forming a stub axle.

5. Vehicle according to claim 4, characterized in that each connection of the yoke with the housing comprises a bush with a swivel pin in it, whereby the swivel pin and the bush revolve with regard to each other, and in which the swivel pin is fastened to the housing or to the yoke and the bush is fastened respectively in the yoke or in the housing.

6. Vehicle according to one of the preceding claims, characterized in that the yoke is C-shaped, with the top end of the yoke, if there is a wheel on the wheel shaft, being located above the wheel and the upper supporting arm being hinged to this end.

7. Vehicle according to one ofthe preceding claims, characterized in that, ifthe wheel suspension is built into the vehicle, the lower supporting arm is connected with the body of the vehicle under the floor of the vehicle.

8. Vehicle according to claim 7, characterized in that the lower supporting arm is connected to the vehicle near its longitudinal central surface.

9. Vehicle according to one of the preceding claims, characterized in that the yoke consists of at least two parts connected to each other which can be taken apart.

10. Vehicle according to claim 9, characterized in that the yoke is divided near the hinge point of the lower supporting arm and the yoke.

11. Vehicle according to one of the preceding claims, characterized in that the wheel shaft extends with an end from the housing on the side ofthe yoke, with a brake disc being fastened to the specified protruding end.

12. Vehicle according to one of the preceding claims, characterized in that the transmission in the housing comprises at least two steps, one of which is present on each side ofthe electric motor, with the outgoing shaft ofthe electric motor being fastened to the incoming shaft of one of the steps, the outgoing shaft being hollow and going through the electric motor and being connected with the incoming shaft of the other step whose outgoing shaft is fastened to the wheel shaft that goes through the specified hollow shaft.

13. Vehicle according to one of the preceding claims, characterized in that the vehicle comprises a subframe to which the supporting arms are hingedly connected with an end.

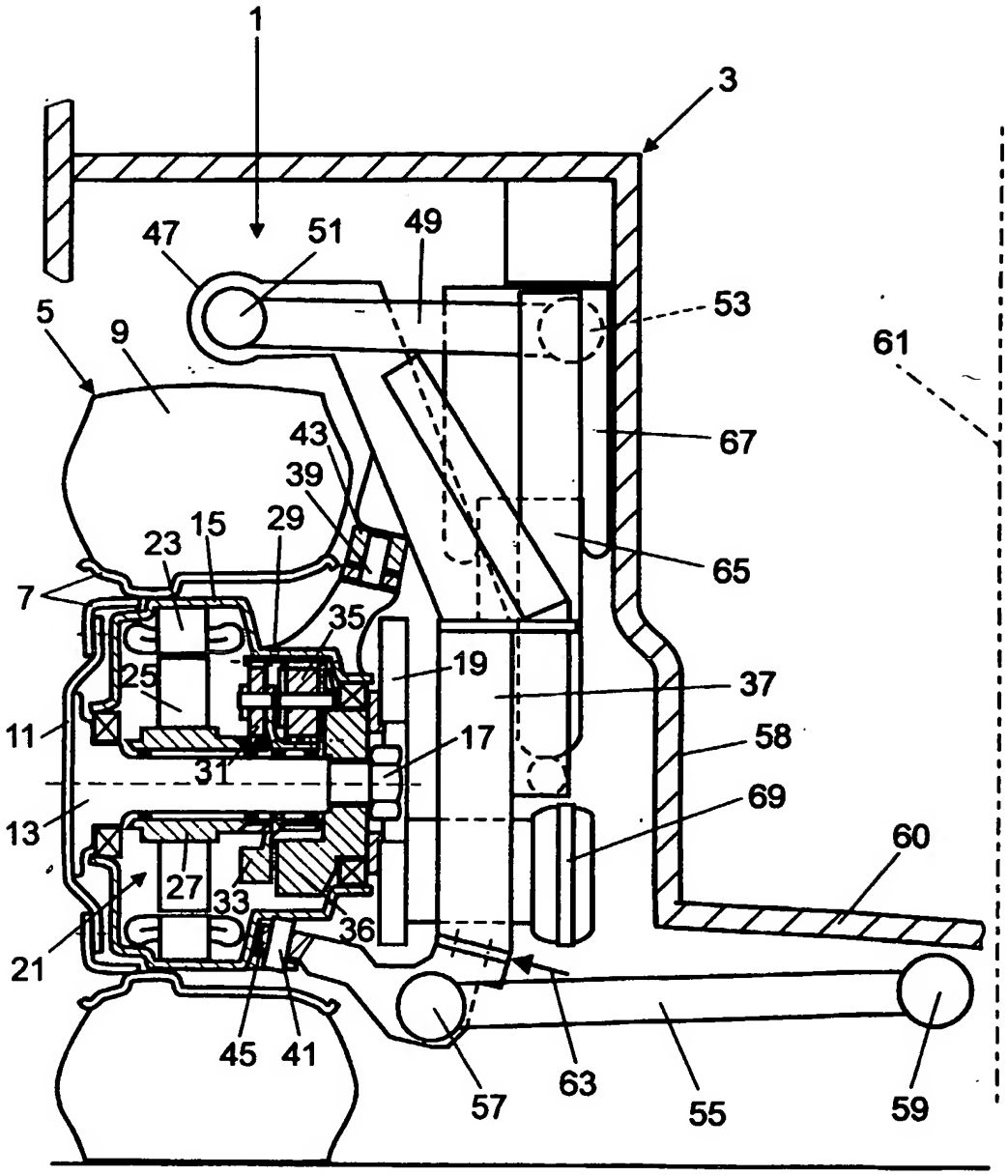
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FIG. 1

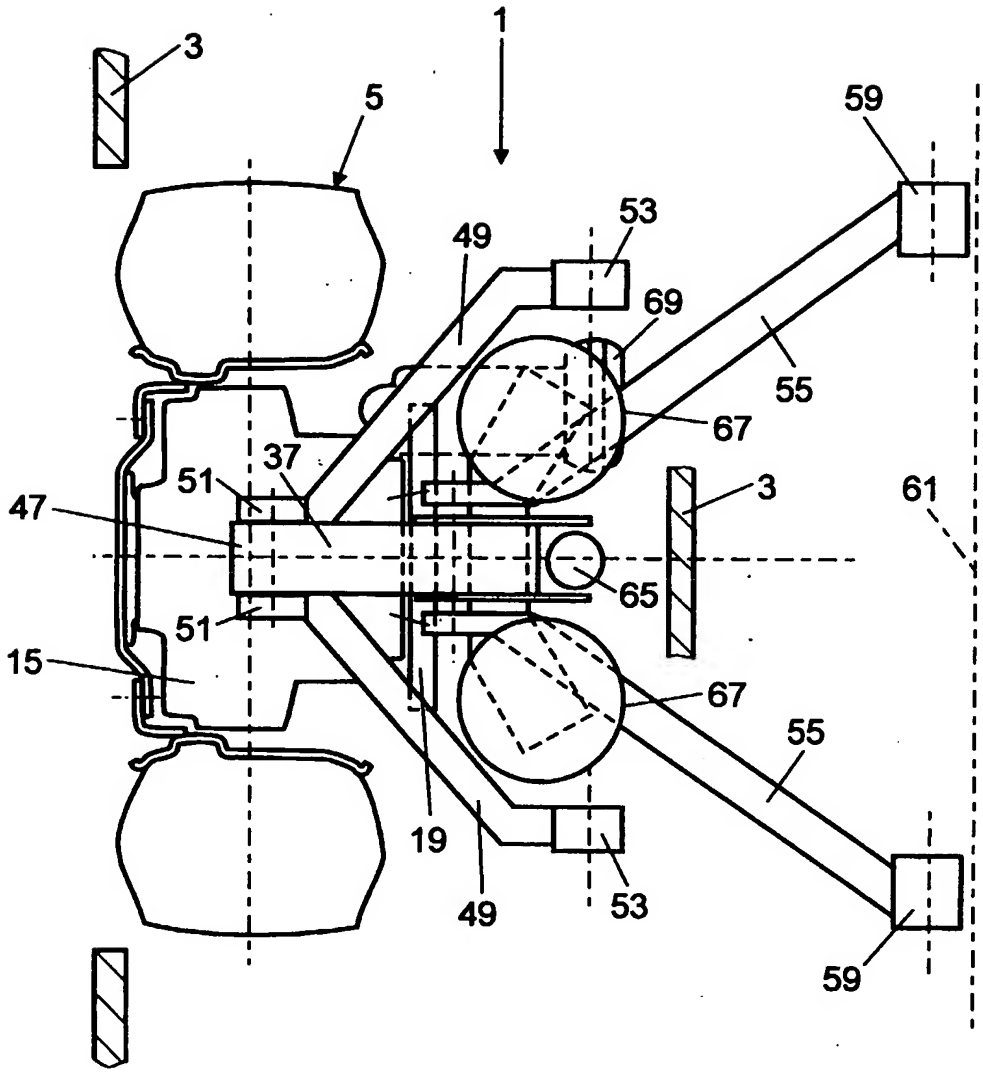

FIG. 2

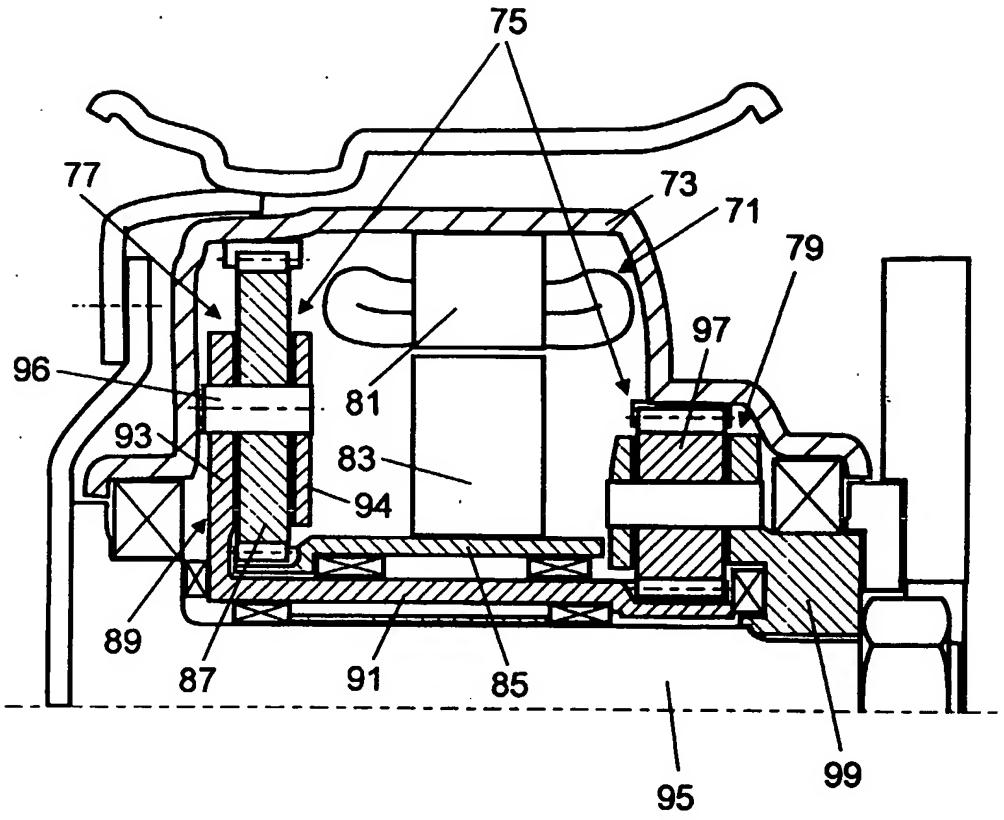

FIG. 3

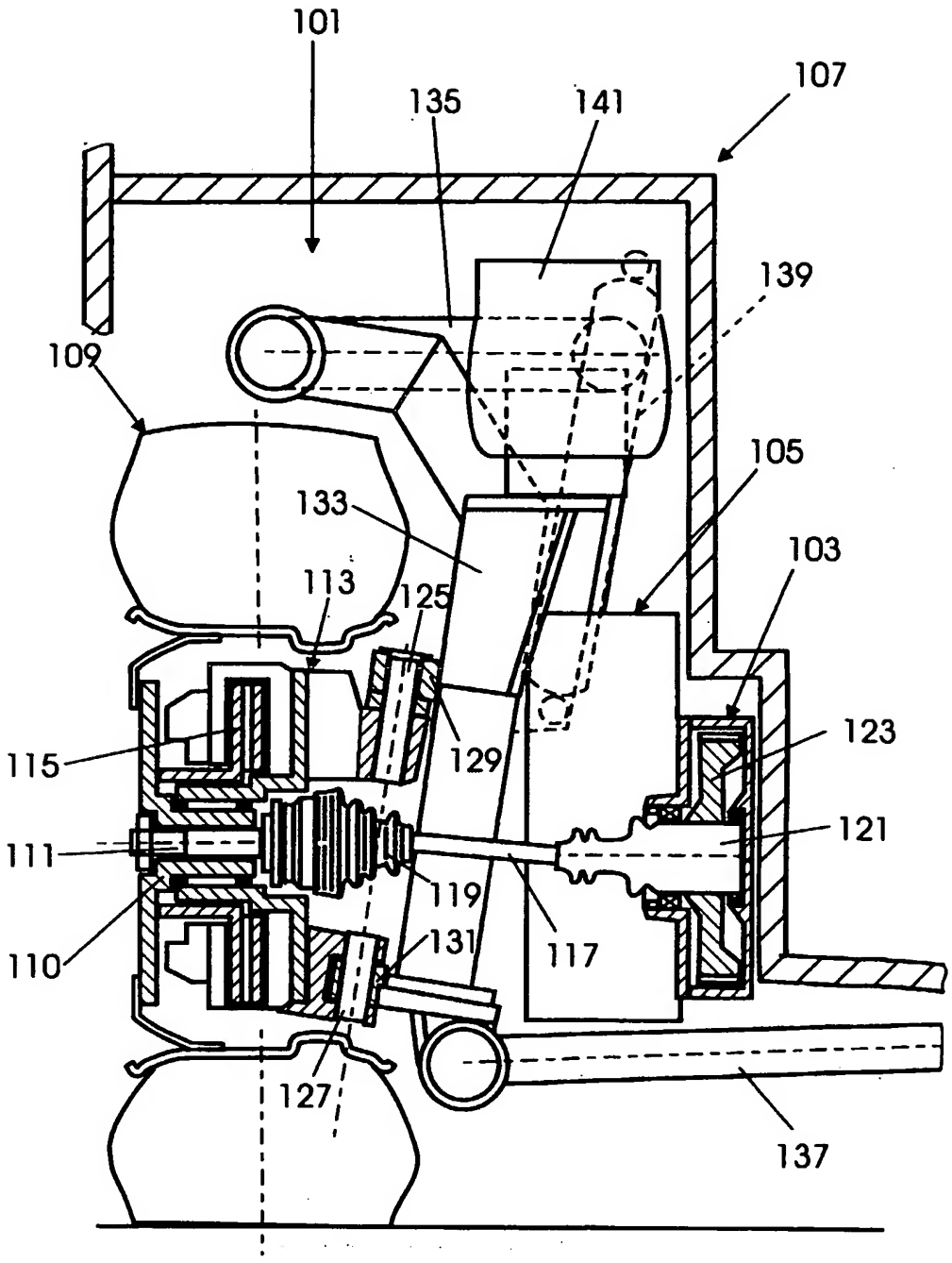
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FIG. 4

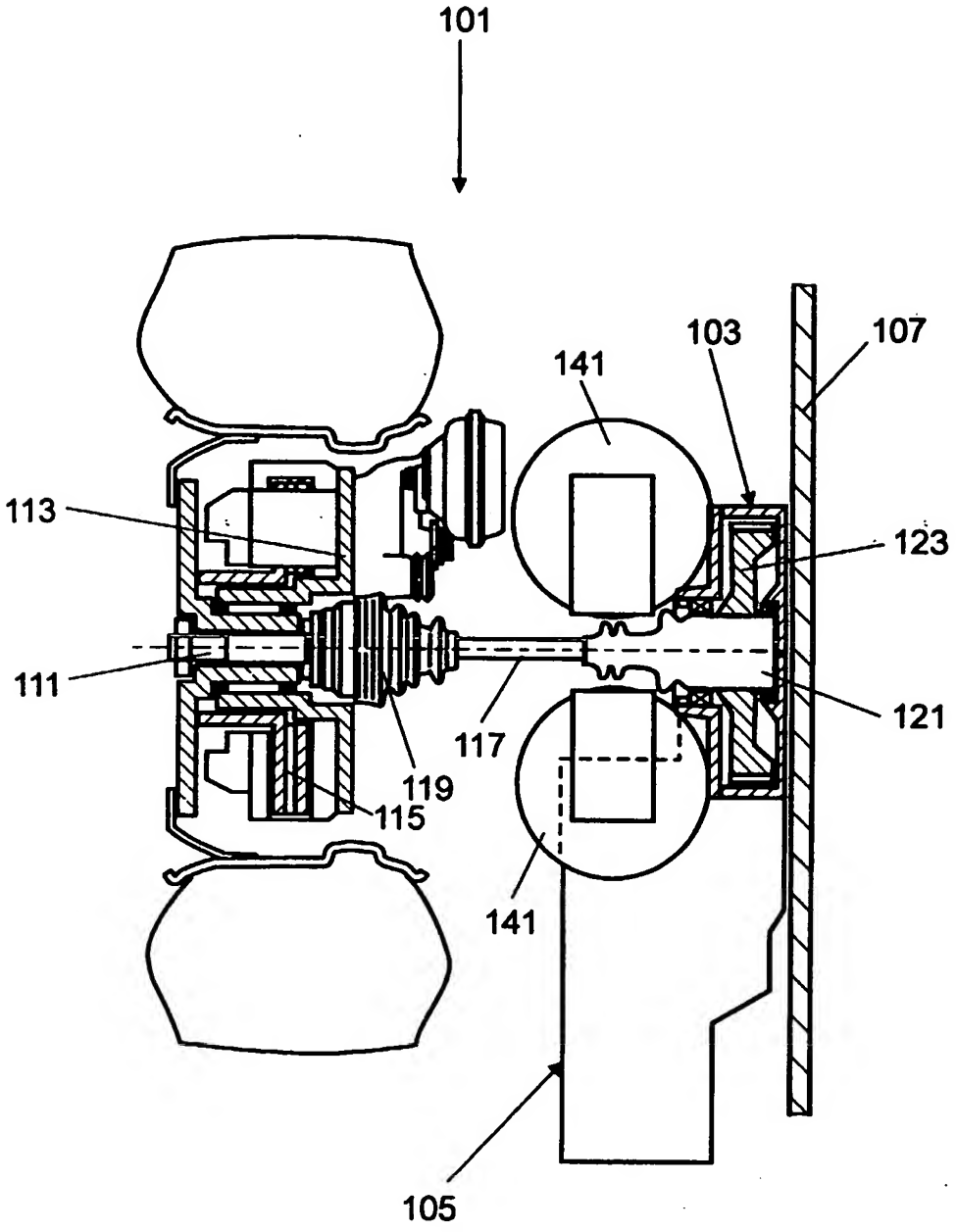

FIG. 5

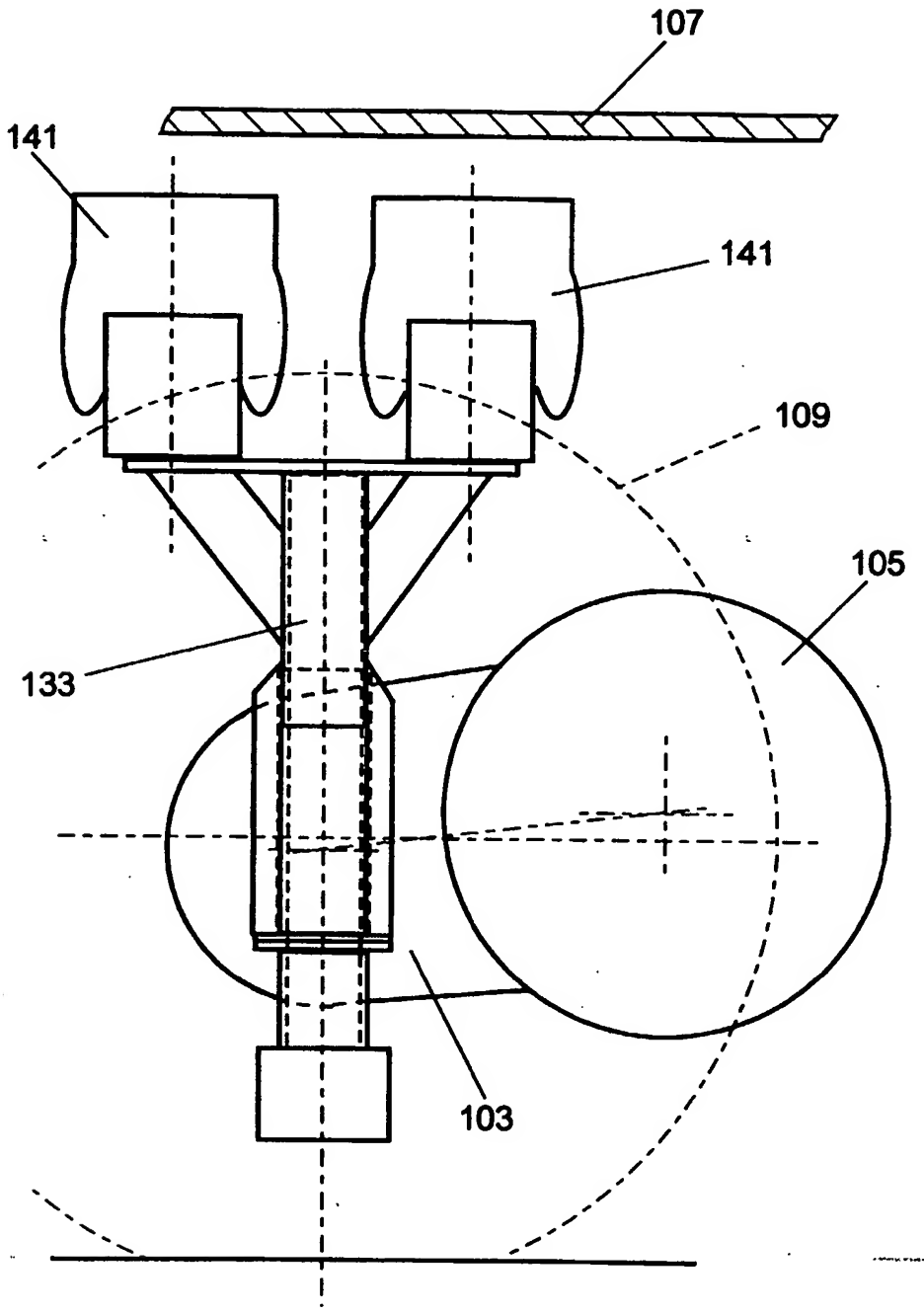

FIG. 6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 20 0128

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	19 April 1999	Zaegel, B

CATEGORY OF CITED DOCUMENTS

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